

Claims:-

1. A load movement control system for a winch or crane system located on a vessel, the winch or crane system including a lift wire, the load movement control system comprising:-

a) a control means to permit an operator to instruct the winch or crane system to at least raise, hold or lower the lift wire;

b) a vessel motion detection means for detecting heave acting upon the vessel and winch or crane system;

c) lift wire resonance prevention means for measuring and/or predicting the tension in the lift wire; and

a control device capable of

- i) receiving outputs from the a) operator control means, b) vessel motion detection and c) lift wire resonance prevention means and:-
- ii) controlling the winch or crane system in response to said outputs.

2. A load movement control system according to claim 1, further comprising a control device including a computation means.

3. A load movement control system according to claim 2, wherein the control device is capable of receiving an output from a load movement device and is further capable of controlling the winch or crane system in response to said output.

4. A method of controlling the movement of a load raised or lowered by a winch or crane system provided on a vessel, the winch or crane system including a lift wire, the method comprising the steps of:-

- a) providing an output from an operator control means which indicates if an operator instructs raising, holding or lowering of the lift wire;
- b) providing an output indicative of heave acting upon the vessel and winch or crane system;
- c) providing an output indicative of a prediction and/or measurement of resonance generated in the lift wire; and
- d) adjusting the pay out or recovery of the lift wire in response to the said outputs a) to c).

5. A heave compensation apparatus for a winch or crane system, the winch or crane system including a lift wire, the apparatus comprising:-

- a lift wire tension measuring device for measuring the tension in the lift wire;
- and a control device capable of receiving an output from the lift wire tension measuring device and controlling the winch or crane system according to the changes in tension in the lift wire, so as to stabilise the load.

6. A heave compensation apparatus according to claim 5, further comprising a load motion measurement device for measuring the motion of the load, and the control device is capable of receiving an output from the load motion measurement device

and controlling the winch or crane system according to the movement of the load.

7. A heave compensation apparatus according to either of claims 5 or 6, wherein when the winch or crane system is provided on a vessel, the apparatus further comprises a vessel motion measurement device for measuring the motion of the vessel, and the control device is capable of receiving an output from the vessel motion measurement device and controlling the winch or crane system according to the movement of the vessel.

8. A heave compensation apparatus according to any of claims 5 to 7, further comprising a lift wire distance measurement device which measures the length of lift wire that has been paid out.

9. A method of heave compensation for a winch or crane system, the winch or crane system including a lift wire, the method comprising the steps of:-
measuring the tension in the lift wire; and
adjusting the pay out or recovery of the lift wire to compensate for the changes in the measured tension.

10. A method according to claim 9, wherein the step of monitoring changes in the tension applied to the lift wire comprises the step of receiving an output from a lift wire tension measurement device indicative of the changes in the tension.

11. A method according to either claim 9 or claim 10, wherein the lift wire is paid out when the tension in the lift wire increases, and the lift wire is recovered when the tension in the lift wire decreases, in order to attenuate natural resonance effects of the lift wire.

12. A heave compensation apparatus for a winch or crane system, the winch or crane system including a lift wire for attachment to a load, the apparatus comprising:-

a load motion measurement device for measuring the motion of the load, and a control device capable of receiving an output from the load motion measurement device and controlling the winch or crane system according to the movement of the load, so as to stabilise the load.

13. A heave compensation apparatus according to claim 12, wherein when the winch or crane system is provided on a vessel, the apparatus includes a vessel motion measurement device for measuring the motion of the vessel, and the control device is capable of receiving an output from the vessel motion measurement device and controlling the winch or crane system according to the movement of the vessel.

14. A heave compensation apparatus according to either of claims 12 or 13, further comprising a lift wire distance measurement device which measures the length of lift wire that has been paid out.

15. A heave compensation apparatus according to any of claims 12 to 14, further comprising a lift wire tension measuring device for measuring the tension in the lift wire.

16. A method of heave compensation for a winch or crane system, the winch or crane system including a lift wire, the method comprising the steps of:-

monitoring the movement of a load suspended by the lift wire; and

adjusting the pay out or recovery of the lift wire to compensate for the movement of the load.

17. A heave compensation apparatus for a winch or crane system, the winch or crane system including a lift wire for attachment to a load, the apparatus comprising:-

a lift wire distance measurement device which measures the length of lift wire that has been paid out, and a control device capable of receiving an output from the lift wire distance measurement device and controlling the winch or crane system according to the distance measured, so as to stabilise the load.

18. A method of heave compensation for a winch or crane system, the winch or crane system including a lift wire, the method comprising the steps of:-

measuring the length of lift wire paid out; and

adjusting the pay out or recovery of the lift wire to stabilise the load.

19. A heave compensation apparatus for a winch or crane system, the winch or crane system being provided on a vessel and including a lift wire for attachment to a load, the apparatus comprising:-

a vessel motion measurement device for measuring the motion of the vessel;

and a control device capable of receiving an output from the vessel motion measurement device and controlling the winch or crane system according to the movement of the vessel, so as to stabilise the load;

wherein the apparatus further comprises at least one of:-

a) a lift wire tension measuring device for measuring the tension in the lift wire;

b) a lift wire distance measurement device which measures the length of lift wire that has been paid out; and

c) a load motion measurement device for measuring the motion of the load.

20. A heave compensation apparatus according to claim 19, wherein the load motion measurement device comprises a motion reference unit coupled to the load.

21. A heave compensation apparatus according to either of claims 19 or 20, wherein the control device comprises a control computer coupled to the drive unit for the winch or crane system.

22. A heave compensation apparatus according to any of claims 19 to 21, wherein the control device is operable to control, in addition to controlling the pay out and recovery of the lift wire in response to inputs from a human operator, the pay out and recovery of the lift wire in response to the output from any of the following:-

- the lift wire tension measuring device; and/or
- the vessel motion measurement device; and/or
- the load motion measurement device; and/or
- the lift wire distance measurement device.

23. A heave compensation apparatus according to any of claims 19 to 22, wherein the control device calculates the elasticity of the lift wire from the length of wire paid out, by reference to its elasticity characteristics.

24. A heave compensation apparatus according to any of claims 19 to 23, wherein an effective mass of the load forms a further input to the control device, wherein the effective mass of the load comprises a mass of the load itself, an added mass, and drag loads.

25. A heave compensation apparatus according to any of claims 19 to 24, further comprising a vessel motion reference unit to measure vessel movements, wherein an output from the vessel motion reference unit forms a further input to the control device.

26. A method of heave compensation for a winch or crane system provided on a vessel, the winch or crane system including a lift wire, the method comprising the steps of:-

monitoring the motion of the vessel and controlling the winch or crane system according to the movement of the vessel by adjusting the pay out or recovery of the lift wire to stabilise the load; and further comprising at least one of the following steps:-

- a) measuring the tension in the lift wire;
- b) measuring the length of lift wire that has been paid out; and
- c) measuring the motion of the load.

27. A method of heave compensation according to claim 26, wherein the step of monitoring movement of a load suspended from the lift wire comprises the step of receiving an output from a load motion reference device that is indicative of the movement of the load.

28. A method of heave compensation according to either of claims 26 or 27, wherein the lift wire is paid out when the movement of the load is such that the tension in the lift wire increases, and the lift wire is recovered when the movement of the load is such that the tension in the lift wire decreases.